Study of Variation in Concentration of Elements in Foods

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Summary: The present study is aimed at the detrmination of concentartion of diverse elements like Na, Ca, K, Mg, Cu, Fe, Ni, Cd, Cr, Mn, Zn and Pb in mineral rich food representative samples of wheat flour, spinach, apple and milk. Variations in element concentration in food during the day was also determined by collecting samples in the morning and evening from three busy commercial areas of Rawalpindi at Saidpur Road, Faizabad Chowk and Commercial Market. Seventy-two samples collected from three points from each place were dried, grinded and digested in Nitric acid and Perchloric acid and analyzed by Atomic Absorption Spectrophotometer. Results revealed that concentration of each element varies with type of food due to their natural occurrence, sampling time and sampling place ranging from 0.01 ppm – 14 ppm. It was also revealed that alkali and alkaline earth metals show decraese in concentration in the evening due to their involvement in redox reactions and bond formation with other elements however, Cu, Fe, Ni, Cd, Cr, Mn, Zn and Pb showed increased variation during the day with lead depicting a maximum of 0.78 ppm. It may be due to the deposition of fuel, smoke containing lead on food. Wheat flour, spinach, apple and milk were found to have upper limits of 13.2 ppm of Mg, 4.88 ppm of Cu, 14 ppm of K and 10.1 ppm of Ca respectively. Variations in sampling place regarding increase in concentration of elements during the day was found to follow the order: Saidpur Road>Faizabad Chowk > Commercial Market due to compareitively more diverse traffic and vendor stands in the first two places.

Introduction

Elements like nickel, copper, iron, manganese and zinc required in trace amount and sodium, calcium, potassium and magnesium required in significant amount by the living organisms are involved in various body functions. Excessive concentration of these metals are toxic, however elements such as lead, cadmium are toxic even at much lower levels [1].

Metal content of food varies in concentration from one food to another e.g. Zinc content of foods varies from 2000 mg/kg in oysters to below 5 mg/kg in refined foods or foods with a high fat content. Fruits, vegetables, whole grains and seeds also have variable concentration of elements. However, processing of foods with stainless steel equipment increases concentration of elements, especially if the food is acidic [2]. Increase of element concentration in food take place not only due to food components, but also involve nonfood components (contaminants) and chemicals. Contaminants are included unintentionally in food. Common environmental contaminants of greatest concern are elements, most notably lead and cadmium. Contaminants enter the food supply and pose serious threat to human health. Toxicity arises when the concentration of some food substances rises from permissible levels. Elements are primarily distributed in atmosphere, water, soil and sediments. Atmospheric metal pollution arises mainly from mining, smelting, burning of fossil fuels, refining of metallic ores, manufacturing and use of metallic products [3]. Toxic element content of foods is influenced by many factors ranging from environmental conditions during growth to post-harvest handling, processing, preparation and cooking techniques. Element content increases in some commodities grown in contaminated soils or atmospheres [4]. Industrial chemicals (liquid or gaseous) and fossil fuel products from combustion engines in vehicles deposit and penetrate in food. Food gets contaminated with processing chemicals and elements coming from equipment, which increases their concentration to unacceptable levels [4]. Toxicity in food also results from metallic cookware made of aluminum, copper, iron, nickel, steel, etc.

The significance of study lies in evaluating the concentration of elements in food and the effects of their toxicities and it will help to create common user awareness and making suggestions for improving general public health. It will also facilitate the health and food inspectors in maintaining food quality and

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developing strategies to reduce contamination level in food and will help to determine various sources of pollution and the effect of climatic and meteorological conditions on distribution of elements in food.

Results and Discussion

Samples of different food items i.e. wheat flour, spinach, apple and milk were collected in the months of July-August, 2001 in morning and evening from three busy commercial areas along Murree Road of Rawalpindi. Three different sampling points were selected from each sampling area, taking one from the center and one from each of the two ends of the sampling area. Variation was observed in the food samples of the same food item collected from three different sampling points. For example in Table-1 it is observed that the samples of spinach collected from Saidpur Road in the morning showed variation in the concentration of Iron (Fe) at sampling point 1 (3.69 ppm), sampling point 2 (3.8 ppm) and sampling point 3 (3.7 ppm) of the sampling area. This may be attributed to the fact that spinach is a naturally rich source of Iron. Secondly the roots of certain plants like spinach and other leafy vegetables reduce Ferric (Fe^{3+}) to Ferrous (Fe^{2+}). After absorption by the roots

Table-1: Concentration (in ppm) of Elements in Food at Saidpur Road

Elements	Wheat Flour		Apple		Spinach		Milk	
	Morn	Even	Morn	Even	Morn	Even	Morn	Even
Sampling point 1								
Pb	0.87	1.63	0.36	0.77	1.76	2.65	0.74	1.34
Cd	0.12	0.36	0.11	0.25	0.6	0.88	0.05	0.25
Ni	2.13	2.48	1.62	1.89	1.32	1.71	1.89	2.13
Cr	0.78	1.03	1.07	1.11	2.09	2.4	0.1	0.21
Mn	2.44	2.71	0.87	1.04	1.49	1.82	1.01	1.13
Zn	4.44	4.8	2.21	2.56	3.1	3.51	3.21	3.41
Fe	3.7	4.2	3.1	3.3	3.69	4.21	1.04	1.7
Cu	3.31	4	4.31	4.76	4.3	4.85	1.56	2
Na	13.1	12.9	0.09	0.07	12.7	12.6	4.4	4.2
Mg	8.4	8.2	3	2.9	6	5.8	7	6.86
K	9.6	9.4	4.1	4.1	13.8	13.7	6.2	6
Ca	9.6	9.5	1.06	1.04	7.8	7.6	9.8	9.6
Average	4.87	5.10	1.83	1.98	4.89	5.14	3.08	3.24
STDEV	4.24	3.98	1.50	1.53	4.43	4.20	3.13	2.91
Sampling point 2								
Pb	0.92	1.62	0.47	0.79	1.35	2.27	0.43	1.08
Cd	0.19	0.41	0.20	0.36	0.45	0.69	0.07	0.28
Ni	1.86	2.19	1.20	1.44	1.45	1.83	2.00	2.35
Cr	0.96	1.18	1.01	1.07	2.08	2.44	0.13	0.26
Mn	2.77	3.02	1.01	1.20	1.50	1.82	1.03	1.17
Zn	4	4.43	2.5	2.80	3.33	3.76	3.23	3.44
Fe	3.8	4.1	3.51	3.76	3.8	4.3	1.04	1.55
Cu	3.21	4	4.3	4.88	4.1	4.56	1.52	2.11
Na	13.2	12.9	0.08	0.06	12.8	12.6	4.5	4.3
Mg	8.5	8.2	2.8	2.8	6.1	5.9	7.05	6.97
K	9.8	9.4	4.02	4	14	13.9	5.9	5.76
Ca	9.7	9.6	1.07	1.08	7.7	7.5	9.6	9.4
Average	4.91	5.09	1.85	2.02	4.89	5.13	3.04	3.22
STDEV	4.28	3.98	1.51	1.57	4.50	4.25	3.09	2.87
Sampling point 3								
Pb	0.75	1.54	0.33	0.70	1.05	2.00	0.66	1.27
Cd	0.25	0.50	0.09	0.28	0.31	0.61	0.10	0.29
Ni	2.08	2.38	1.08	1.33	0.92	1.27	1.10	1.41
Cr	0.81	1.01	1.33	1.45	1.94	2.23	0.12	0.22
Mn	2.76	3.01	1.03	1.21	1.12	1.46	1.12	1.25
Zn	3.8	4.19	2	2.33	3.19	3.63	3.12	3.35
Fe	3.7	4.2	3.33	3.68	3.7	4.1	1.03	1.67
Cu	3.34	3.88	4.28	4.75	4	4.66	1.46	2.03
Na	12.8	12.67	0.07	0.06	13	12.8	4.5	4.4
Mg	8.3	8.3	3.1	3	6.12	6	7.1	7
K	9.6	9.6	4.01	4	13.8	13.7	6	5.87
Ca	9.6	9.4	1.07	1.05	8	7.8	9.8	9.6
Average	4.82	5.06	1.81	1.99	4.76	5.02	3.01	3.20
STDEV	4.17	3.95	1.51	1.54	4.63	4.38	3.16	2.95

it is transported to the shoots and then passed on to the leaves where it is stored [5]. Thirdly spinach has a high concentration of water, comprising 94.8 % of its total composition [6]. High concentration of Iron can also be referred to the fact that leafy plants such as spinach has a special association with iron and is known to exist in the form of oxides and hydroxides [7].

The variation in elemental concentration was also observed in the morning and evening of the food samples. There was an increase in concentration of cadmium, lead, nickel, chromium, manganese, iron, copper and zinc in all food samples collected in the evening from all locations. This variation appeared to be very significant in case of lead as the maximum concentration of lead in spinach in evening was found to be 2.65 ppm as compared to maximum concentration (1.87 ppm) in morning. Elemental variation was observed to be higher in the samples collected from Saidpur Road (2.65 ppm) and Faizabad Chowk (2.03 ppm) than the samples collected from Commercial Market (1.89 ppm) (See Table-1, 2, 3). It may be due to the emission of smoke and combustion of petrol release tetramethyl and tetraethyl Lead [8], which disperses in air and penetrate the food. Moreover, there are many tinning, welding and repair workshops in these areas. Besides the vendors display spinach and other vegetables openly, which allows for direct exposure to the dust, smoke, trace metals and other contami-nants. In order to keep the vegetables fresh especially spinach the vendors occasionally sprinkle water over spinach during the day, this may increase the deposi-tion and penetration of metals like Iron, Copper, etc.

The ambient levels of dust and smoke from the industrial area (especially the dust from the steel mill) reaching the sampling area also contributes to the increasing levels of evening iron concentration. Saidpur Road is narrow and unmetalled at some places and is frequently used as a link between Rawalpindi and Islamabad, leading to high concentration of traffic. Saidpur Road is open to all type of traffic so there is no restriction on the movement of donkey carts and tongas. At Faizabad Chowk there are many van and bus stands, which not only invite heavy vehicles but are also responsible for the congestion and crowd during most of the day. Faizabad Fly over not only links Rawalpindi and Islamabad but also provides for many other link roads. The relatively lower variation observed at Commercial Market may be attributed to the fact that this sampling area is not exactly situated at Murree Road rather it leads into a residential area. Here the roads are properly metalled and it is not open to all types of traffic, therefore there is less traffic. The cars are usually parked and there are no vendor stands or stalls. The shops are generally covered so the food is not directly exposed. The presence of a public park in this area also contributed to the decreasing of air pollution by absorbing much of the unsettled dust.

Another interesting detail is that the concentration of alkali and alkaline earth metals like Sodium (Na), Calcium (Ca), Potassium (K), Magnesium (Mg), etc. tend to show a slight decrease during the day. Certain trace metals like Lead, Cadmium, Chromium, etc. are known to have certain chemical association with alkali and alkaline earth metals including Na, Ca, K and Mg forming bonds and performing oxidation reduction reactions [2]. These reactions may ultimately alter the concentration of alkali and alkaline earth metals. In case of food they may react during the day to reduce the concentration of these elements. For example the concentration of calcium in milk decreased slightly. This may be due to the fact that milk is generally transported in metallic containers made from iron aluminum, copper, lead, etc. This allows leaching of metals from the containers into the milk. In some cases milk is even boiled in such containers. Elements such as lead which have a special bonding capacity with calcium tend to leach easily. Other metals like iron and copper are also susceptible to certain chemical processes in this respect. If milk is placed in stainless steel utensils then the toxic metals like nickel (Ni) and Chromium (Cr) may leach into milk. The study revealed that the least variation in the morning and evening concentration is observed in apple. It may be due to the presence of apple peel, which prevents dust, trace metals, etc. from entering into the fruit. Highest variation is observed in case of wheat flour and spinach, as they are directly exposed to smoke and dust containing trace metals, etc. Moreover, all green leafy vegetables are known to absorb more dust and metals due to increased surface area.

Experimental

Seventy-two different food samples of milk, wheat, apple and spinach were collected twice a day i.e., morning and evening, each from three different sampling locations along Murree Road, Rawalpindi.

Table 2 Concentration (in ppm) of Elements in Food at Faizabad Chowk.

Elements	Wheat Flour		Apple		Spinach		Milk	
	Morn	**Even**	**Morn**	**Even**	**Morn**	**Even**	**Morn**	**Even**
				Sampling point 1				
Pb	0.76	1.28	0.29	0.53	1.21	2.03	0.71	1.17
Cd	0.18	0.37	0.07	0.24	0.39	0.67	0.06	0.17
Ni	2.11	2.33	1.36	1.55	0.98	1.22	2.41	2.64
Cr	0.90	1.00	1.21	1.27	1.89	2.10	0.09	0.15
Mn	2.12	2.33	1.02	1.16	1.09	1.39	1.07	1.17
Zn	3.9	4.26	2.4	2.66	2.92	3.27	3.22	3.38
Fe	3.6	4	3.53	3.8	4	4.5	1	1.51
Cu	3.41	3.76	4.35	4.78	4.28	4.78	1.51	2.11
Na	12.9	12.6	0.07	0.05	12.8	12.7	4.5	4.4
Mg	8.5	8.3	2.8	2.74	6.3	5.9	7.03	6.85
K	9.4	9.34	4.12	4.1	13.9	13.6	5.87	5.8
Ca	9.4	9.3	1.08	1.05	8.1	7.8	9.6	9.4
Average	4.77	4.91	1.86	1.99	4.82	5.00	3.09	3.23
STDEV	4.19	3.98	1.54	1.59	4.61	4.35	3.06	2.88
				Sampling point 2				
Pb	0.69	1.24	0.37	0.58	1.8	2.60	0.77	1.20
Cd	0.16	0.38	0.08	0.26	0.32	0.57	0.07	0.17
Ni	2.13	2.38	1.75	1.92	1.38	1.63	1.9	2.21
Cr	0.91	1.06	0.98	1.02	2.15	2.30	0.11	0.18
Mn	2.25	2.48	0.73	0.86	1.42	1.71	0.98	1.11
Zn	4.00	4.34	2.10	2.38	3.13	3.48	3.20	3.39
Fe	3.52	3.9	3.5	3.8	4.1	4.6	1.01	1.51
Cu	3.31	3.71	4.31	4.63	4.3	4.81	1.46	2.01
Na	13	12.8	0.05	0.03	12.6	12.5	4.3	4.3
Mg	8.5	8.4	2.8	2.7	5.81	5.8	7	6.85
K	9.5	9.4	4.12	4.11	113.8	13.7	5.74	5.7
Ca	9.3	9.2	1.06	1.05	7.9	7.7	10.1	9.9
Average	4.77	4.94	1.82	1.95	13.23	5.12	3.05	3.21
STDEV	4.21	4.01	1.54	1.58	31.86	4.23	3.15	2.98
				Sampling point 3				
Pb	0.91	1.42	0.39	0.68	1.39	2.14	0.51	1.00
Cd	0.17	0.38	0.15	0.28	0.48	0.77	0.09	0.19
Ni	1.83	2.04	1.66	1.82	1.01	1.26	1.44	1.68
Cr	0.62	0.74	1.33	1.36	2.11	2.34	0.15	0.20
Mn	2.19	2.41	0.97	1.12	1.01	1.29	1.11	1.21
Zn	3.40	3.71	2.12	2.41	2.89	3.28	3.34	3.55
Fe	3.5	4	3.55	3.71	4.2	4.83	1.02	1.46
Cu	3.2	3.78	4.34	4.74	4.17	4.71	1.41	2.1
Na	12.8	12.7	0.02	0.01	12.7	12.6	4.3	4.2
Mg	8.2	2.7	2.7	2.65	6.11	5.77	6.7	6.69
K	9.4	4.14	4.14	4.12	13.7	13.7	5.68	5.75
Ca	9.3	9.3	1.06	1.04	8.1	7.8	10	9.7
Average	4.63	3.94	1.87	2.00	4.82	5.04	2.98	3.14
STDEV	4.18	3.60	1.51	1.55	4.52	4.33	3.12	2.95

Areas selected were busy commercial zones with heavy traffic like Faizabad Chowk, Saidpur Road and Commercial Market. Three sampling points (starting, mid and end-point) were marked for each sampling location. Food samples were collected separately in sufficient quantities in pre-cleaned, airtight glass containers and were labeled. Flour samples were kept at room temperature whereas milk was refrigerated until required. Spinach leaves and apple were cut into small pieces with sterilized knife, placed on clean and labeled blotting sheets, kept in open air for 24 – 36 hours and then oven dried at 60 °C for 24 hours. All samples of spinach and apple were grinded separately in a sterilized pestle and mortar to a fine powder. Two grams each of grinded spinach, apple, and flour were measured using an electronic analytical balance (model number MP-3000 Chyo). 2 ml of milk was pipetted (10 ml) and transferred to 75 ml digestion tubes of 3 cm diameter. 5ml of nitric acid (65 % conc.) was added drop-wise to the digestion tubes and were placed in preheated kjeldahl digestion block for 45 minutes. After cooling at room temperature, 1.25 ml of 70 % perchloric acid was added drop by drop and again heated on heating bath at 60 °C until a

Table-3: Concentration (in ppm) of Elements in Food at Commercial Market

Elements	Wheat Flour		Apple		Spinach		Milk	
	Morn	Even	Morn	Even	Morn	Even	Morn	Even
				Sampling point 1				
Pb	0.74	1.02	0.41	0.59	1.54	1.89	0.45	0.80
Cd	0.20	0.32	0.12	0.22	0.41	0.61	0.09	0.13
Ni	2.01	2.17	1.29	1.39	1.35	1.70	2.40	2.59
Cr	0.83	0.89	1.05	1.08	2.17	2.24	0.08	0.11
Mn	2.36	2.53	1.05	1.15	1.19	1.37	1.02	1.10
Zn	3.20	3.47	2.10	2.33	2.99	3.22	3.11	3.30
Fe	3.4	3.6	3.08	3.21	4.1	4.3	1.01	1.23
Cu	3.31	3.5	4.37	4.41	4.11	4.32	1.4	1.62
Na	12.8	12.64	0.06	0.04	12.6	12.6	4.5	4.4
Mg	8.2	7.9	2.75	2.7	.84	5.74	6.85	6.8
K	9.5	9.42	3.95	3.93	13.7	13.5	5.75	5.69
Ca	9.4	9.4	1.06	1.03	7.8	7.7	9.6	9.5
Average	4.66	4.74	1.77	1.84	4.40	4.93	3.02	3.11
STDEV	4.18	4.05	1.46	1.45	4.56	4.29	3.05	2.96
				Sampling point 2				
Pb	0.73	0.99	0.34	0.48	1.48	1.79	0.69	1.06
Cd	0.18	0.32	0.06	0.14	0.31	0.48	0.07	0.13
Ni	2.10	2.27	1.33	1.45	1.28	1.47	1.65	1.85
Cr	0.82	0.88	1.00	1.04	1.76	1.81	0.14	0.17
Mn	2.22	2.40	0.97	1.06	1.00	1.21	1.00	1.08
Zn	2.8	3.07	2.22	2.38	2.21	2.50	3.43	3.57
Fe	3.7	3.8	3.33	3.51	4.03	4.3	1	1.28
Cu	3.21	3.43	4.2	4.4	3.86	4.12	1.5	1.78
Na	13	12.9	0.06	0.05	12.5	12.4	4.4	4.3
Mg	8.4	8.2	2.61	2.6	5.73	5.7	6.92	6.68
K	9.63	9.42	3.9	3.87	13.9	13.7	5.9	5.74
Ca	9.6	9.5	1.05	1.05	8	7.8	9.6	9.4
Average	4.70	4.77	1.76	1.84	4.67	4.77	3.03	3.09
STDEV	4.28	4.14	1.47	1.49	4.56	4.40	3.07	2.91
				Sampling point 3				
Pb	0.98	1.27	0.43	0.55	1.01	1.40	0.58	0.97
Cd	0.15	0.30	0.10	0.20	0.47	0.65	0.09	0.16
Ni	2.33	2.48	1.35	1.48	1.65	1.79	2.10	2.27
Cr	0.87	0.95	1.09	1.11	2.07	2.13	0.12	0.17
Mn	2.15	2.30	0.99	1.12	1.29	1.53	0.92	0.97
Zn	3.40	3.62	2.11	2.31	2.23	2.48	3.22	3.35
Fe	3.3	3.5	3.29	3.44	3.86	4.1	1.01	1.22
Cu	3.3	3.46	4.32	4.42	4.4	4.65	1.41	1.61
Na	12.8	12.6	0.07	0.06	12.7	12.5	4.3	4.2
Mg	8.3	8.3	2.64	2.62	5.8	5.7	6.87	6.8
K	9.52	9.41	4.02	4.01	13.8	13.6	5.8	5.76
Ca	9.4	9.3	1.05	1.03	7.8	7.6	9.7	9.6
Average	4.71	4.79	1.79	1.86	4.76	4.84	3.01	3.09
STDEV	4.17	4.03	1.48	1.48	4.51	4.34	3.07	2.97

clear solution was formed. For purification, solution was filtered through Whatman filter paper no. 40 and the filtrate was diluted to 100 ml with distilled water. The sample solutions were analyzed by Atomic Absorption Spectrophotometer (model number GBC 923 Plus, from Germany) for the estimation of lead, cadmium, nickel, chromium, zinc, manganese, iron, copper, sodium, calcium, magnesium and potassium.

Conclusions

The following conclusions may be drawn from the present study.

Different food shows varying concentration of various elements due to the natural occurrence or abundance of elements in a particular food. Concentration of lead, cadmium, nickel, chromium manga-nese, zinc, iron and copper increases in the evening due to enhanced deposition of dust particles and aerosols with time. A slight decrease is observed in the evening concentration of sodium, magnesium, potassium and calciumThe variations in the concentration of Lead, Cadmium, Chromium, Nickel, Manganese and Zinc in morning and evening are more in case of food samples collected from Saidpur

Table-4: Minimum and Maximum Concentration (in ppm) of Elements in Food at Saidpur Road, Faizabad Chowk and Commercial Market.

Elements	Wheat flour		Apple		Spinach		Milk	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Saidpur Road								
Pb	0.75	1.63	0.33	0.79	1.05	**2.65**	0.43	1.34
Cd	0.12	0.50	0.09	0.36	0.31	**0.88**	0.05	0.29
Ni	1.86	2.48	1.08	1.89	0.92	1.83	1.10	2.35
Cr	0.78	1.18	1.01	1.45	1.94	**2.44**	0.10	0.26
Mn	2.44	3.02	0.87	1.21	1.12	1.82	1.01	1.25
Zn	3.80	4.80	2.00	2.80	3.10	3.76	3.12	3.44
Fe	3.7	4.2	3.1	3.76	3.69	4.3	1.04	1.7
Cu	3.21	4	4.28	4.88	4	**4.85**	1.46	2.11
Na	12.67	13.2	0.06	0.09	12.6	13	4.2	4.5
Mg	8	8.5	2.8	3.1	5.8	6.12	6.68	7.1
K	9.4	9.8	4	4.1	13.7	**14**	5.56	6.2
Ca	9.4	9.7	1.04	1.08	7.5	8	9.4	9.8
Average	4.68	5.25	1.72	2.13	4.64	5.30	2.85	3.36
STDEV	4.13	4.07	1.49	1.57	4.51	4.32	3.01	2.98
Faizabad Chowk								
Pb	0.69	1.42	0.29	0.68	1.21	2.60	0.51	1.20
Cd	0.16	0.38	0.07	0.28	0.32	0.77	0.06	0.19
Ni	1.83	2.41	1.36	1.92	0.98	1.76	1.44	**2.64**
Cr	0.62	1.06	0.98	1.36	1.89	2.34	0.09	0.20
Mn	2.12	**2.48**	0.73	1.16	1.01	1.71	0.98	1.21
Zn	3.40	**4.34**	2.10	2.66	2.89	3.48	3.20	3.55
Fe	3.5	4	3.5	3.8	4	**4.83**	1	1.51
Cu	3.2	3.78	4.31	4.78	4.17	4.81	1.41	2.11
Na	12.6	**13.2**	0.01	0.07	12.5	12.8	4.2	4.5
Mg	8	8.5	2.65	2.8	5.77	6.3	**6.69**	7.03
K	9.34	9.5	4.1	4.14	13.6	13.9	5.68	5.87
Ca	9.2	9.4	1.04	1.08	7.7	8.1	9.4	**10.1**
Average	4.56	5.04	1.76	2.06	4.67	5.28	2.89	3.34
STDEV	4.14	4.10	1.55	1.57	4.48	4.32	3.01	3.04
Commercial Market								
Pb	0.73	1.27	0.34	0.59	1.01	1.89	0.45	1.06
Cd	0.15	0.32	0.06	0.22	0.31	0.65	0.07	0.16
Ni	2.01	2.48	1.28	1.48	1.28	1.79	1.65	2.59
Cr	0.82	0.95	1.00	1.11	1.76	2.24	0.08	0.17
Mn	2.15	2.53	0.97	1.15	1.00	1.53	0.92	1.10
Zn	2.80	3.62	2.10	2.38	2.21	3.22	3.11	3.57
Fe	3.3	3.8	3.08	3.51	3.86	4.3	1	1.28
Cu	3.21	3.5	4.2	4.42	3.86	4.65	1.4	1.78
Na	12.6	13	0.04	0.06	5.84	6.68	6.92	4.5
Mg	7.9	8.4	2.6	2.75	5.7	5.84	6.68	6.92
K	9.41	9.63	3.87	4.02	13.5	13.9	5.69	5.9
Ca	9.3	9.6	1.03	1.06	7.6	8	9.4	9.7
Average	4.53	4.93	1.71	1.90	3.99	4.56	3.11	3.23
STDEV	4.14	4.14	1.44	1.49	3.77	3.71	3.21	3.00

Road and Faizabad Chowk. It is due to heavy traffic, unsettled dust, directly exposure of food to open air etc.

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